PATENT SPECIFICATION

NO DRAWINGS

Inventor: JEROME RUSSELL WHITE

1,087,815

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Date of Application and filing Complete Specification: Aug. 7, 1964.
No. 32307/64.
Application made in United States of America (No. 302489) on Aug. 8, 1963.
Application made in United States of America (No. 316542) on Oct. 16, 1963.
Application made in United States of America (No. 356957) on April 2, 1964.
Complete Specification Published: Oct. 18, 1967.
SEE ERRATA SLIP ATTACHED

Index at acceptance:—**H1** H(2, 3A, 3C, 5C1, 5C2, 6B, 8A, 8B); **B2** E(1A, 1H); **B5** K3; **B5** N(17X, 17Y, 19Y, 22X, 22Y, 24Y, 54X, 55Y, 69Y, 71X, 184, 188, 191, 195, 234, 238, 241, 245, 250, 252X, 270X, 280X, 282X, 283X, 285X, 286X, 360, 548, 570, 633, 682, 690, 713, 745, 796); **C4** A(C6A, C12G, X3); **C4** X5; **C5** W(5A, 8A1, 8A2, 8B2)

Int. Cl.:—**H 05 b 5/00**//B 29 d, B 32 b, C 09 d, j, C 11 b

COMPLETE SPECIFICATION

Improvements in or relating to Heating using Alternating Magnetic Fields

We, E. I. DU PONT DE NEMOURS AND COMPANY, a corporation organized and existing under the laws of the State of Delaware, located at Wilmington, State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of heating materials using alternating magnetic fields, and also to structures comprising a material adapted for use in such methods.

In many processes for heating materials, it is desired to have complete control of the degree of heating, the precise location of heating and the rate and duration of the heating and cooling cycles. One such process involves heat-sealing flexible substrates such as paper, paperboard, glassine, etc. having coated thereon a heat-activatable protective adhesive organic coating, to thereby form cartons or other containers, such as milk cartons, or cartons or packages for other food products. In such a process the amount or degree of heating is important. Excessive heat will destroy or damage the organic coating and/or char the substrate. Also the coating may melt throughout the entire layer and diffuse into the porous substrate, thus destroying the adhesive effectiveness thereof. Insufficient heating will not properly activate the coating thus prohibiting the formation of adherent bonds. The location of the heating is important since it is only necessary to heat the coating in the precise areas where the coating must be activated, such as in the area of overlapping flaps. In some processes it is absolutely critical that the material should not be heated except in certain precise areas. The rate and duration of the heating and cooling cycles is also important. If the rate and duration of heating are too long, the process will be forced to operate at an undesirably slow pace to permit adequate heating. Similarly, if the rate of cooling is too long, the individual work pieces cannot be immediately stacked or placed adjacent to other surfaces, thus hampering the rate of output of the process. On the other hand, if the duration of heating is too short, the coating will not be properly activated. Similar problems are encountered in other processes for heating other materials.

Practitioners of the art have proposed several processes for heating materials where such problems are encountered. However, no completely satisfactory methods have heretofore been devised. For example, a U.S. Patent 2,393,541, issued to Kohler, describes a technique whereby conductive metal particles are dispersed in the material which is applied to a substrate as desired. The assembly is then subjected to a magnetic field causing the metal particles to heat, primarily by hysteresis losses, thereby heating the material. While this technique, as described, is suitable for many purposes, the rate of heating the metal particles is inherently unduly slow, requiring

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SPECIFICATION No. 1,087,815

Page 7, Agents signature, *for* "FRANK B. DEHN" *read* "FRANK B. DEHN & CO."

THE PATENT OFFICE
1st May 1968

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Practitioners of the art have proposed several processes for heating materials where such problems are encountered. However, no completely satisfactory methods have heretofore been devised. For example, a U.S. Patent 2,393,541, issued to Kohler, describes a technique whereby conductive metal particles are dispersed in the material which is applied to a substrate as desired. The assembly is then subjected to a magnetic field causing the metal particles to heat, primarily by hysteresis losses, thereby heating the material. While this technique, as described, is suitable for many purposes, the rate of heating the metal particles is inherently unduly slow, requiring

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several minutes to properly heat the material. Thus, this technique is not suitable for high speed, mass production processes.

Another technique is described in U.S. Patent 2,475,758, issued to Vore, whereby heat-sealable surfaces may be activated by providing an electrically conductive band of metal particles in contact with the heat-sealable surfaces, which is then subjected to an electromagnetic field. The electrically conductive band is heated by inductive heating (eddy current losses), which activates the heat-sealable surfaces. Again, this technique, as described, is suitable for many purposes. The electrically conductive band is heated in a fraction of a second, provided it is heavily loaded with the electrically conductive metal particles. However, it is difficult to control the degree of heating using this technique, since by inductive heating, the temperature of the metal particles continues to rise above the Curie point thereof. This in turn, can lead to degradation of the material, resulting in charring of the substrate, and other undesirable effects.

An object of this invention is to provide an improved method of heating materials.

An additional object is to provide materials adapted for use in such processes.

According to the invention there is provided a method of heating a material comprising associating said material with finely divided, multidomain, non-conductive antiferromagnetic particles as herein defined so that heat generated in said particles is transferred to said material, and subjecting the said particles to an alternating magnetic field having a frequency of at least 10 megacycles per second whereupon the temperature of said particles increases towards a maximum temperature equal to the Néel temperature of the particles and said material is heated thereby.

The terminology used to describe the magnetic properties of materials, unfortunately, is not uniform in the literature in respect of the terms "ferrimagnetic" and "antiferromagnetic". In Waldron, Ferrites, D. Van Nostrand Co. Ltd., London, (1961) p. 31, it is recited that the name "ferrimagnetism" was given by Néel to the phenomenon of the alignment of electron spins in anti-parallel directions, and the name "anti-ferromagnetism" to the case of "ferrimagnetism" in which the anti-parallel spins cancel exactly these terms becoming generally accepted; Waldron goes on however to state that this use of these terms is misleading and apt to cause confusion and proposes to abandon the term "ferrimagnetism" and to use the term "anti-ferromagnetism" in its place, and proposes a new terminology such as "balanced anti-ferromagnetism" to define the phenomenon which Néel called "anti-ferromagnetism". This state of confusion is confirmed in Van Der Ziel, *Solid State Physical Electronics*, (1957) pp. 552—553. For the purposes of this specification and in order to avoid confusion as employed hereafter the words "anti-ferromagnetic material as herein defined", are intended to define a material of the type which Néel called "ferrimagnetic", i.e. a material which embodies the phenomenon of the alignment of electron spins in anti-parallel directions. It is to be noted that anti-ferromagnetic materials as herein defined are uncompensated as explained in the above mentioned Van Der Ziel reference.

These antiferromagnetic materials as herein defined are all familiar to those skilled in the art and are to be found among sulfides, oxides or mixed oxides of chromium, manganese, iron, cobalt, and nickel, either alone where appropriate or together with oxides or mixed oxides of the alkali metals (i.e., lithium, sodium, potassium, and rubidium), alkaline earth metals (i.e., beryllium, magnesium, calcium, strontium, barium, and radium), rare earth metals (i.e., lanthanum and the other elements of atomic numbers 57 to 71 of the periodic table), and other metals, such as copper, zinc, vanadium, titanium, and aluminium, wherein the compound has certain crystal structures, in particular, spinel, garnet, perovskite, or pyrrotite. The preferred antiferromagnetic materials as herein defined are those including the oxides and mixed oxides of chromium, manganese, iron, cobalt, and nickel either alone or in combination with the other metals, described above, and preferably those wherein the compound has the spinel crystal structure.

These antiferromagnetic materials as herein defined are electrically nonconductive, that is, they have electrical resistances of at least 10^{-2} ohm-cm. and typically of up to 10^{9} ohm-cm., and higher.

It is critical that the antiferromagnetic material as herein defined be finely divided. However, it is also essential that the finely divided particles be multidomained, that is, each particle must contain more than one, and preferably many, "Bloch walls" which separate regions of magnetization, and which are termed "domains". These domains are thin laminar transition regions in which the magnetization changes from the direction existing outside the wall on one side to the direction existing on the outside of the other side of this wall, the directions differing by either 180 or 90 angular degrees. Thus the lower limit on particle size is determined by the factor that the particle must be multidomained. The precise size of the domain varies with different materials. Particles on the order of 0.01 microns in size have been known to be multidomained. The particles may be as large as 5 microns in size. Preferably, the particles range from 0.1 to 5 microns in size. Par-

ticle size is critical to this invention, primarily to insure proper heating characteristics, but also to obtain proper suspension of the particles in a liquid medium, and to render the coating of such particles smooth to the touch.

It should be noted that these antiferromagnetic materials as herein defined, inherently, are extremely friable. Therefore, ordinary grinding equipment, such as a ball-mill, may be used to conveniently obtain the requisite finely-divided particle sizes. By way of contradistinction, the conductive metal particles used heretofore are far less friable. When these previously used conductive metals are reduced in size, the particles fuse together, or "smear", as they approach the size of the finely-divided particles used in this invention. In fact, it is extremely difficult to obtain particles of conductive metals less than 75 microns in size. A few complicated methods are available for producing such finely-divided conductive metal particles such as particular complex chemical precipitations in liquid media, and by vapor deposition onto a fluid surface. However, these latter techniques, obviously, are totally unsuitable in uses such as contemplated for the present invention.

For convenience, these finely-divided multidomain particles of nonconductive antiferromagnetic material as herein defined are referred to hereinafter as "antiferromagnetic particles as herein defined".

It will be appreciated that the Néel temperature of the antiferromagnetic material as herein defined determines the maximum temperature to which the material is heated upon subjection to the alternating magnetic field that is, once the material reaches its specific Néel temperature the magnetic effects cease, and the temperature of the material will not be raised further. This effect is similar to that known in the art which is associated with the Curie temperature of ferromagnetic metals. However, the antiferromagnetic materials as herein defined typically have a much more abrupt transition at their néel temperature than do the metals at their Curie temperature. Furthermore, the antiferromagnetic materials as herein defined generally possess a relatively high and uniform permeability over the whole temperature range from room temperature to the Néel temperature so that considerable heating is produced at all temperatures between the starting temperature and the desired final temperature. This results in both extremely rapid heating and fine temperature control.

Thus, the degree or amount of heating is precisely controlled by selection of an antiferromagnetic material as herein defined having a particular Néel temperature. Such materials are commercially available having various Néel temperatures, and therefore, selection of the proper antiferromagnetic material as herein defined is within the ordinary skill of practitioners of the art. Normally, it is necessary to select an antiferromagnetic material as herein defined having a Néel temperature of at least the temperature to which it is desired to heat the material to be heated. The upper temperature is limited only by the degradation temperature of the material to be heated and/or the degradation temperature of any substrate or other adjacent bodies.

The alternating magnetic field must have a frequency of at least 10 megacycles per second, and preferably in the range 40 to 2500 megacycles. Ordinary conductive metal particles as used in prior art processes are magnetically responsive, i.e., become heated, when subjected to an alternating magnetic field in the kilocycle per second range, or one megacycle at the most. However, the antiferromagnetic particles as herein defined used in this invention are not sufficiently responsive to such frequency, heretofore considered "high frequency". Instead, they must be subjected to a field having a frequency at at least 10 megacycles per second in order to heat at a practical rate. The particles reach their Néel temperature within milliseconds upon subjection to such extremely high frequencies, whereas the ordinary conductive metal particles may require on the order of several minutes to heat. Upon removal from, or disruption of, the magnetic field, the antiferromagnetic particles as hereindefined cool to room temperature, again within milliseconds.

It should be noted that the conductive metals used in the art heretofore in conjunction with relatively low frequency magnetic radiation, are for all practical purposes, completely inoperable in the present invention which employs the extremely high frequency alternating magnetic field of at least 10 megacycles per second and preferably, at least 40 megacycles per second. Upon subjection to such frequencies, the conventional conductive metal particles spark, resulting in tracking, charring of the substrate and nonuniform heat patterns.

In passing it is also noted that the density of the conductive metals used in the art heretofore generally is about twice that of the antiferromagnetic materials as herein defined used in this invention. Consequently, the prior art conductive metal particles are difficult to suspend in a liquid medium to produce a satisfactory ink or the like.

To ensure optimum efficiency, the magnetic field must have a flux density of at least 50 gauss, with 50 to 500 gauss being the normal operating range, and 100 to 300 gauss being the preferred range.

This invention provides a heat source for heating a wide variety of materials to attain

a useful result. For example, certain solid thermoplastics may be melted to secure adhesive properties associated with the so-called hot-melt adhesives. Volatile liquids may be evaporated by heating the liquids to their vapor points. Gaseous and liquid materials may be heated to the temperature at which they become reactive in particular chemical reactions. Curable resins may be heated to the temperature at which chemical cross-linking occurs.

Thus, this invention may be used to activate heat-activatable adhesives i.e. adhesives of the type wherein the adherent function of the adhesive is realized when the adhesive is heated such as the various thermoplastic hot-melt adhesives, for example, polymer-modified petroleum wax compositions. Particularly preferred polymer-modified petroleum wax compositions are those containing olefin polymers, such as homopolymers and copolymers of ethylene, propylene, isobutylene, etc., especially ethylene copolymers, that is, ethylene polymers containing one or more additional copolymerized monomer, such as ethylene/vinyl acetate, ethylene/ethyl acrylate, ethylene/1,4-hexadiene, ethylene/methyl methacrylate, ethylene/methacrylic acid and the like. One preferred composition comprises 50 to 99.9% by weight petroleum wax, 50 to 0.1% by weight of an ethylene/vinyl acetate copolymer having a vinyl acetate content of 15 to 35% by weight and a melt index of 0.1 to 500, and 0 to 40% by weight of a resin, esterified resin, rosin or esterified rosin.

As is familiar to those skilled in the art, these heat-activatable adhesives are useful for adhering a variety of different types of substrates such as paper (including the so-called paperboard or cardboard), various metals, plastics, leather, glass, etc., either to like or different substrates. For example, by use of these heat-activatable adhesives in accordance with this invention one metal substrate can be adhered to another metal substrate, metal can be adhered to paper, paper to paper, leather to paper and so forth.

According to the invention therefore there is also provided a method of adhering together at least two surfaces by means of a heat-activatable adhesive, i.e. an adhesive of the type wherein the adherent function of the adhesive is realized when the adhesive is heated, at least one of said surfaces carrying a coating of said heat-activatable adhesive on at least the area thereof to be adhered, comprising associating said adhesive with finely divided, multidomain, non-conductive antiferromagnetic particles as herein defined so that heat generated in said particles is transferred to said adhesive, contacting said surfaces to be adhered and, while said surfaces are in contact, subjecting said particles to an alternating magnetic field having a frequency of at least 10 megacycles per second whereupon the temperature of said particles increases towards a maximum temperature equal to the Néel temperature of the particles and said heat activatable adhesive is heated thereby.

The invention is especially useful for preparing cartons or other containers such as milk cartons, frozen food containers and the like, using such heat-activatable adhesives.

Thus the invention also extends to a blank for erection into a box or carton or other container having end flaps to be adhered when the container is erected from the blank, said end flaps or the portion of the blank registering with the end flaps when the container is erected having coated thereupon a composition comprising finely divided, multidomain, nonconductive, antiferromagnetic particles as herein defined, and a heat-activatable adhesive being coated upon at least part of the blank so as, in erection of the container, to register with the coating of said composition so that when the particles of said composition are subjected to an alternating magnetic field having a frequency of at least 10 megacycles per second their temperature rises towards a maximum temperature equal to the Néel temperature of the particles and the heat-activatable adhesive is heated.

In this way substrates such as carton or container blanks are provided with a coating of the heat-activatable adhesive, at least over the areas of the surfaces thereof to be adhered together. When the aforedescribed polymer-modified petroleum wax compositions are employed, the entire substrate is coated, at least on one side, to provide a protective barrier coating. The adhesive on at least one of the surfaces must be in intimate contact with the finely-divided multidomain nonconductive antiferromagnetic particles as hereindefined. Thus, the particles may be in a physical admixture with the adhesive on one or both of the surfaces to be adhered. However, it is preferred to use the structure provided by this invention which comprises a paper (including the so-called paperboard and cardboard) substrate having coated on at least a portion of the surface thereof (i.e., at least on the areas of the surfaces to be adhered) a heat-activatable adhesive such as a polymer-modified wax composition, and a composition comprising finely divided multidomain nonconductive antiferromagnetic particles as herein defined having particle sizes of less than 5 microns.

The composition comprising the antiferromagnetic particles as herein defined is generally prepared from a dispersion of the particles and a binder such as a natural or synthetic resin or glue, preferably polyvinyl acetate, in a liquid dispersing medium or solvent for the binder such as a lower alcohol, such as methanol, ethanol, isopropanol, etc.

This coating composition is applied to one or both of the surfaces to be adhered in the areas where adherence is desired. The top-coating is then applied at least over the areas covering the above-described coating comprising the antiferromagnetic particles as herein defined, and preferably is applied to at least one entire surface of the substrate. The substrate is then folded, as desired, and is passed through the alternating magnetic field, with the surfaces to be adhered being in contact with each other. The antiferromagnetic particles as herein defined are heated to their Néel temperature and cooled within milliseconds, so that the heat-activatable adhesive is heated and then cooled to a non-tacky temperature also within milliseconds, thus permitting extremely fast mass production.

This invention may also be used to dry ordinary printing inks for use on high speed printing presses, whereby finely-divided antiferromagnetic particles as herein defined are dispersed in the printing ink. Immediately after the substrate is printed, it is passed through an alternating magnetic field, causing the particles to heat and evaporate the solvents used in the ink, effecting virtually instantaneous drying of the ink, and permitting the printed substrates to be immediately stacked after printing. Moreover, since only the ink is heated, and since it is heated and then cooled all within a fraction of a second, the paper itself is not detectably heated. Thus, water which is inherently present in the paper is not evaporated, thereby eliminating any possible shrinking of the paper.

Similarly, this technique can be employed with inks which contain an oxidizable liquid vehicle, such as the lithographic inks based upon linseed oil. By use of this invention the ink vehicle can be virtually instantaneously heated to the proper oxidizing temperature and then cooled, with the above-indicated advantages inherently accruing.

This invention also provides a technique for heating gases or liquids to proper temperature for reactions in chemical processes, by passing the gases or liquids through a fixed or fluid bed of finely-divided multidomain antiferromagnetic particles as herein defined which are continually subjected to an alternating magnetic field. Such a process may be very effectively conducted where the particles are embedded in a catalyst support used in the process.

The following example serves to further illustrate this invention; all parts are by weight unless otherwise stated. A carton of the type generally described in U. S. Patent 2,695,745 was prepared by coating only the flap areas to be sealed of the carton with a composition comprising finely-divided, non-conductive, antiferromagnetic particles as herein defined. This composition was prepared from a commercial ferrite consisting essentially of about 10% NiO, 6% ZnO, 1% MnO and 83% Fe_2O_3, and having a Neel temperature of 385° C., an initial permeability of 115, and a volume resistivity of 2.5×10^7 ohm-cm. at 30° C. This ferrite was ball-milled for about 16 hours in water. The mill slip was then filtered, dried and crushed to an average particle size of about 3 microns. The ferrite particles were then mixed with a 30% solution of polyvinyl acetate (weight average molecular weight of 70,000) in a mixture of methyl and ethyl alcohol, to obtain a composition containing 67% ferrite and 33% polyvinyl acetate solution, having a viscosity of about 700 centipoise. This composition was then coated onto the carton blank flaps as described above. The entire carton blank was then coated with an ethylene/vinyl acetate-paraffin wax composition. The carton blank was folded and positioned on a mandrel, adjacent to an electrode structure in the pressure pad. A 40 megacycle per second alternating magnetic field of 125 gauss was generated. The coating on the flaps reached its sealing temperature within 100 milliseconds, whereupon the alternating magnetic field was disrupted, and the surfaces of the adjacent flaps in contact with each other cooled to room temperature and fused together within 200 milliseconds. No external cooling of the mandrel or pressure pad was required. Strong, paper-tearing, non-leaking bonds were obtained. The coating did not melt elsewhere on the carton. A durable carton was formed.

By repeating the foregoing example using a flux density of 200 gauss, the coating on flaps reached its sealing temperature within 20 milliseconds, at which time the alternating magnetic field was disrupted and the surfaces of the adjacent flaps in contact with each other cooled to room temperature within 100 milliseconds. Again, strong, paper-tearing, nonleaking bonds were obtained; the coating did not melt elsewhere on the carton; and a durable carton was formed.

WHAT WE CLAIM IS:—

1. A method of heating a material comprising associating said material with finely divided, multidomain, non-conductive antiferromagnetic particles as herein defined so that heat generated in said particles is transferred to said material, and subjecting the said particles to an alternating magnetic field having a frequency of at least 10 megacycles per second whereupon the temperature of said particles increases towards a maximum temperature equal to the Néel temperature of the particles and said material is heated thereby.

2. A method as claimed in claim 1 wherein the said material is supported on a substrate of paper, metal, plastic, leather, glass or fabric.

3. A method of adhering together at least two surfaces by means of a heat-activatable adhesive, i.e. an adhesive of the type wherein the adherent function of the adhesive is realized when the adhesive is heated, at least one of said surfaces carrying a coating of said heat-activatable adhesive on at least the area thereof to be adhered, comprising associating said adhesive with finely divided, multidomain, non-conductive antiferromagnetic particles as herein defined so that heat generated in said particles is transferred to said adhesive, contacting said surfaces to be adhered and, while said surfaces are in contact, subjecting said particles to an alternating magnetic field having a frequency of at least 10 megacycles per second whereupon the temperature of said particles increases towards a maximum temperature equal to the Néel temperature of the particles and said heat activatable adhesive is heated thereby.

4. A method as claimed in claim 3 wherein said particles are dispersed in a composition including a binder and a liquid dispersing medium and the dispersion formed thereby is applied as a coating to one or both of the surfaces to be adhered in the areas thereof where adherence is desired.

5. A method as claimed in claim 3 or 4 wherein said heat-activatable adhesive is a polymer-modified petroleum wax composition.

6. A method as claimed in claim 5 wherein said polymer-modified petroleum wax composition comprises 50 to 99.9% by weight of petroleum wax, 50 to 0.1% by weight of an ethylene/vinyl acetate copolymer having a vinyl acetate content of 15 to 35% by weight, and a melt index of 0.1 to 500, and 0 to 40% by weight of a resin, an esterified resin, a rosin or an esterified rosin.

7. A method as claimed in any of claims 3—6 in which said surfaces are paper surfaces.

8. A method as clamed in any of the preceding claims wherein said particles are less than 5 microns in size.

9. A method as claimed in claim 8 wherein said particles are at least 0.01 microns in size.

10. A method as claimed in any of the preceding claims wherein said particles are ferrites.

11. A method as claimed in any of the preceding claims in which said particles have an electrical resistance to 10^{-2} to 10^{9} ohm-cm.

12. A method as claimed in any of the preceding claims wherein said field has a frequency of 40 to 2500 megacycles per second.

13. A method as claimed in any of the preceding claims wherein said field has a flux density of at least 50 gauss.

14. A method as claimed in any of the preceding claims wherein said field has a flux density of not more than 500 gauss.

15. A method as claimed in claim 14 wherein said field has a flux density of 100 to 300 gauss.

16. A method as claimed in any of the preceding claims wherein said particles are subjected to said magnetic field for up to 100 milliseconds.

17. A method of heating a material as claimed in claim 1 and substantially as herein defined.

18. A method of adhering together at least two surfaces by means of a heat-activatable adhesive as claimed in claim 3 and substantially as herein defined.

19. A heat activatable adhesive, i.e. an adhesive of the type wherein the adherent function of the adhesive is realised when the adhesive is heated, comprising a thermoplastic hot-melt adhesive in association with finely divided, multidomain, non-conductive, antiferromagnetic particles as herein defined so that heat generated in said particles is transferred to the said thermoplastic hot-melt adhesive, the said adhesive being capable of being heated towards a maximum temperature equal to the Neel temperature of the said particles when the said particles are subjected to an alternating magnetic field having a frequency of at least 10 megacycles per second so as to realize its adherent function.

20. A heat activatable adhesive as claimed in claim 19, formed upon at least a portion of a substrate of paper, metal, plastic, leather, glass or fabric for example, the said particles being in contact with the said thermoplastic hot-metal adhesive.

21. A heat activatable adhesive as claimed in claim 19 or 20 wherein said particles are less than 5 microns in size.

22. A heat activatable adhesive as claimed in claim 21 wherein said particles are at least 0.01 microns in size.

23. A heat activatable adhesive as claimed in any of claims 19 to 22 wherein said particles are ferrites.

24. A heat activatable adhesive as claimed in any of claims 19—23 in which said particles have an electrical resistance of 10^{-2} to 10^{9} ohm-cm.

25. A heat activatable adhesive as claimed in any of claims 19 to 24 wherein said thermoplastic hot melt adhesive is a polymer modified petroleum wax composition.

26. A heat activatable adhesive as claimed in claim 25 wherein said polymer-modified petroleum wax composition comprises 50 to 99.9% by weight petroleum wax, 50 to 0.1% by weight of an ethylene/vinyl acetate copolymer having a vinyl acetate content of 15 to 35% by weight and a melt index of 0.1 to 500, and 0 to 40% by weight of a resin,

an esterified resin, a rosin or an esterfied rosin.

27. A blank for erection into a box or carton or other container having end flaps to be adhered when the container is erected from the blank, said end flaps or the portion of the blank registering with the end flaps when the container is erected having coated thereupon a composition comprising finely divided, multidomain, non-conductive, antiferromagnetic particles as herein defined, and a heat-activatable adhesive being coated upon at least part of the blank so as, in erection of the container, to register with the coating of said composition so that when the particles of said composition are subjected to an alternating magnetic field having a frequency of at least 10 megacycles per second their temperature rises towards a maximum temperature equal to the Neel temperature of the particles and the heat-activatable adhesive is heated.

28. A blank as claimed in claim 27 wherein said heat activatable adhesive is as claimed in any of claims 19 to 26.

29. A heat activatable adhesive as claimed in claim 19 and substantially as herein described.

30. A blank for erection into a box or carton or other container as claimed in claim 27 and substantially as herein described.

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Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1967.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.